Applied Statistics for Public Health Professionals

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A Policy Context

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- Every year, nearly **471 billion PKR** is being spent on Benazir Income Support Program as part of the broader social protection policy (MoF, 2024).
- Currently, Pakistan has the world's second-highest number of out-of-school children (OOSC) with an estimated **22.8 million children aged 5-16** not attending school, representing **44 percent of the total population** in this age group—(UNICEF, 2024).

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- How does access to clean drinking water affect health outcomes in urban vs. rural populations of Pakistan?
- Does the Sehat Sahulat Program reduce household health expenditure? If so, how much?
- What is the impact of extreme weather events on child malnutrition and the prevalence of waterborne diseases in rural communities?
- Think about recent floods in Punjab!

What is Research?

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- **Public Good**
  - Research contributes to a broader base of knowledge than just researchers own interest.
  - Consequently, it is important that research procedures are described in a way that enables other people to understand them, duplicate them and make judgments about their quality (think about 600 years back).

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- Using data and Experiments.

The Scientific Method

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- When the null hypothesis is supported, it undermines our proposed theory.

The Research-Practice Continuum

Figure: Research-Practice Continuum

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- Making generalization underlies the risk of Biases.

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- Scientists actively seek explanations grounded in causation rather than correlation.
- Scientific Knowledge should be replicable- Other scientists should reach the same conclusion in different contexts (following the same design).

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- Characteristics of Good Theories:
  - Coherent and internally consistent
  - Causal in nature
  - Generate testable hypotheses

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- Concepts are our building blocks to understanding the world and to developing theory that explains the world.

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- The expected relationship is called **THEORY**.

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Examples:

- The effectiveness of public officer is measured by having senior officers rate junior officers on various traits.
- Educational attainment may be measured by how well a student scores on standardized achievement tests.
- Good performance by a city bus driver might be measured by the driver's accident record and by his or her record of running on time.
- The success of a nonprofit agency's fund-raising drive might be measured by the amount of money raised.

Thought-Provoking Question!

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Does this indicate poor performance of district health department?

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- An operational definition is a statement that describes how a concept will be measured.
- An indicator is a variable, or set of observations, that results from applying the operational definition.

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- Patients' satisfaction with the service of the Hospital is measured according to the response categories that patients check on a questionnaire item (high satisfaction, medium satisfaction, and low satisfaction).

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- One reason for using *multiple indicators* is that a concept may have more than one dimension.

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- Reliability, by contrast, refers to *how consistent the measure is with repeated applications*.
- A measure is reliable if, when applied to the repeated observations in similar settings, the outcomes are consistent.

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- Measurement is *straight-forward* when we can *directly observe the phenomenon*.
- Measurement becomes more challenging when you *cannot directly observe the concept of interest*.

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- Question:
- Is the CSS examinations a valid indicators of on-the-job performance of civil servants?

Validity and Reliability

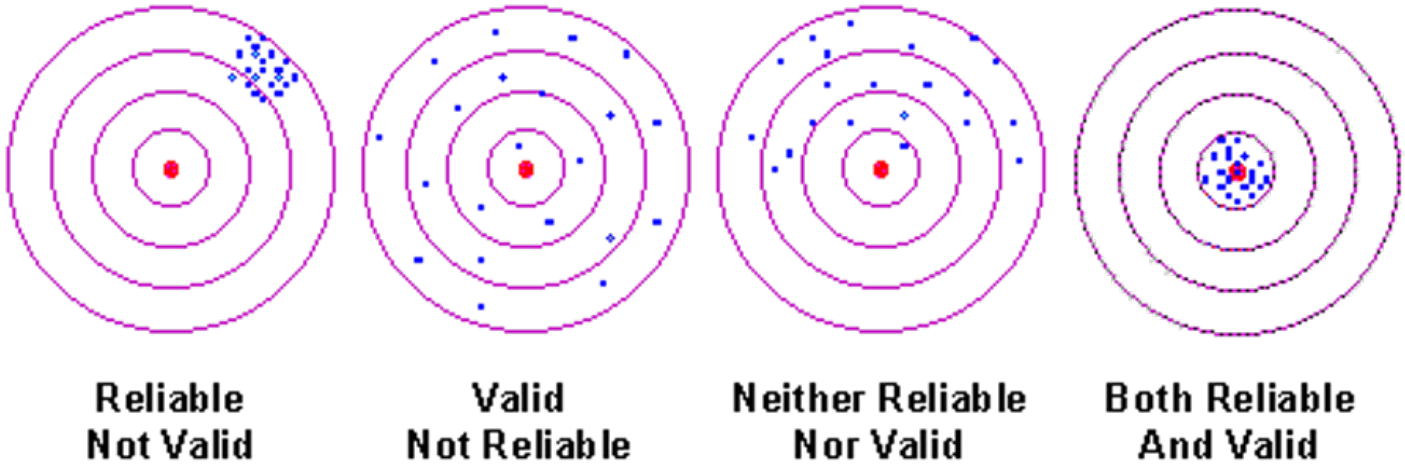

Figure: Validity and Reliability

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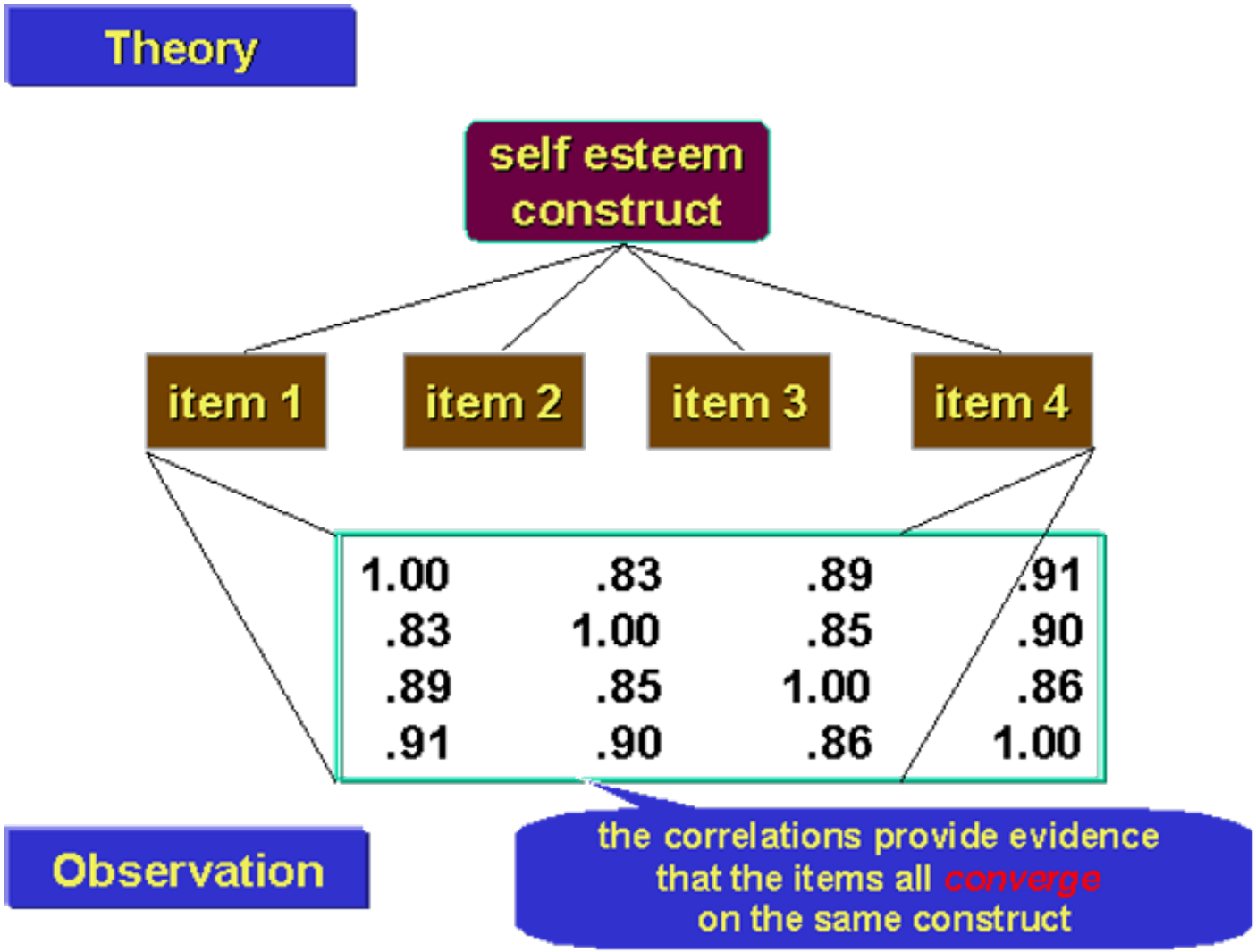
    - E.g. you should be able to show a correspondence or convergence between similar constructs

Convergent Validity



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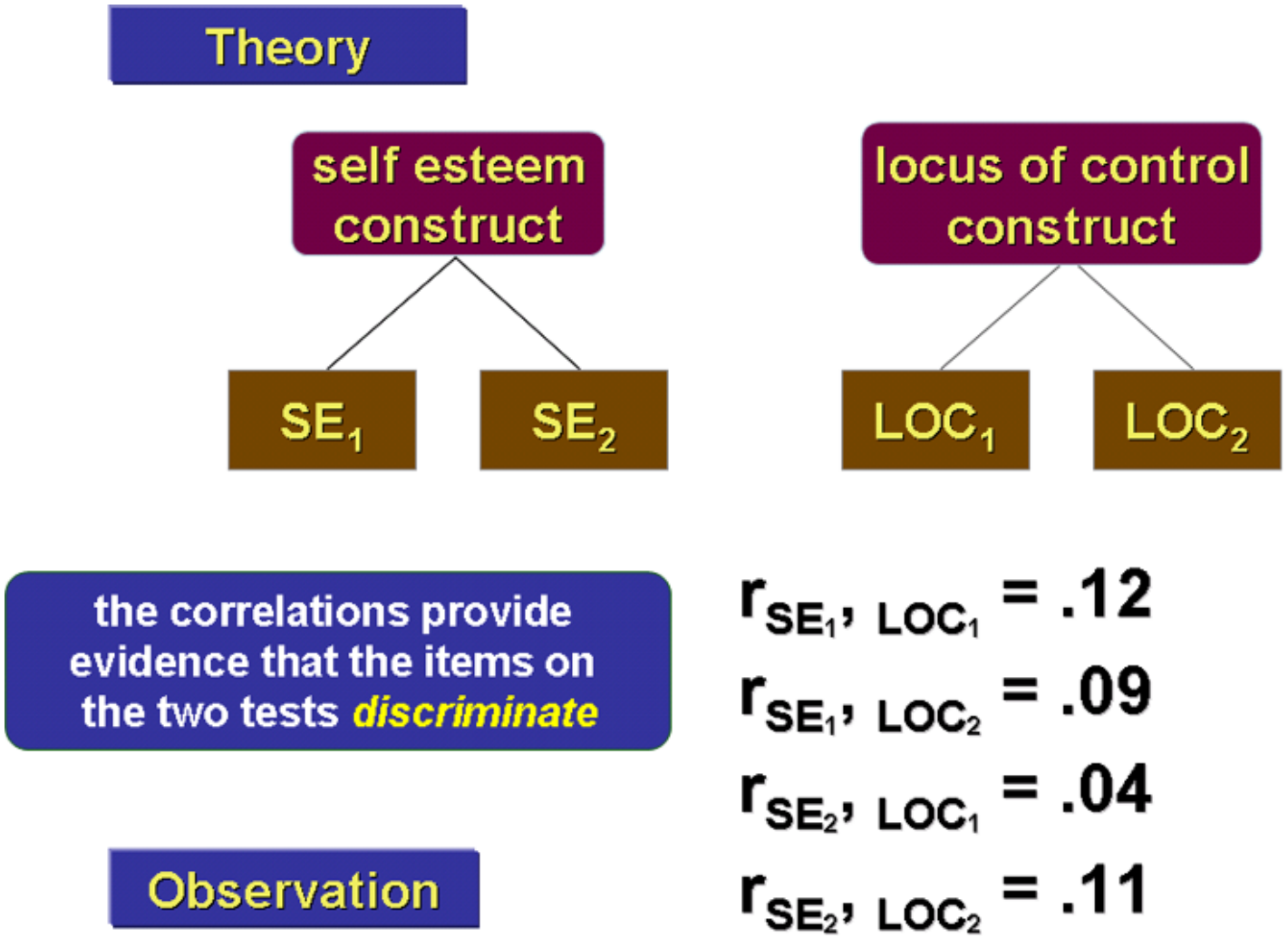
- Measures of constructs that theoretically **should not be related** to each other are, in fact, **observed to not be related** to each other.
  - e.g. you should be able to discriminate between dissimilar constructs

Discriminant Validity



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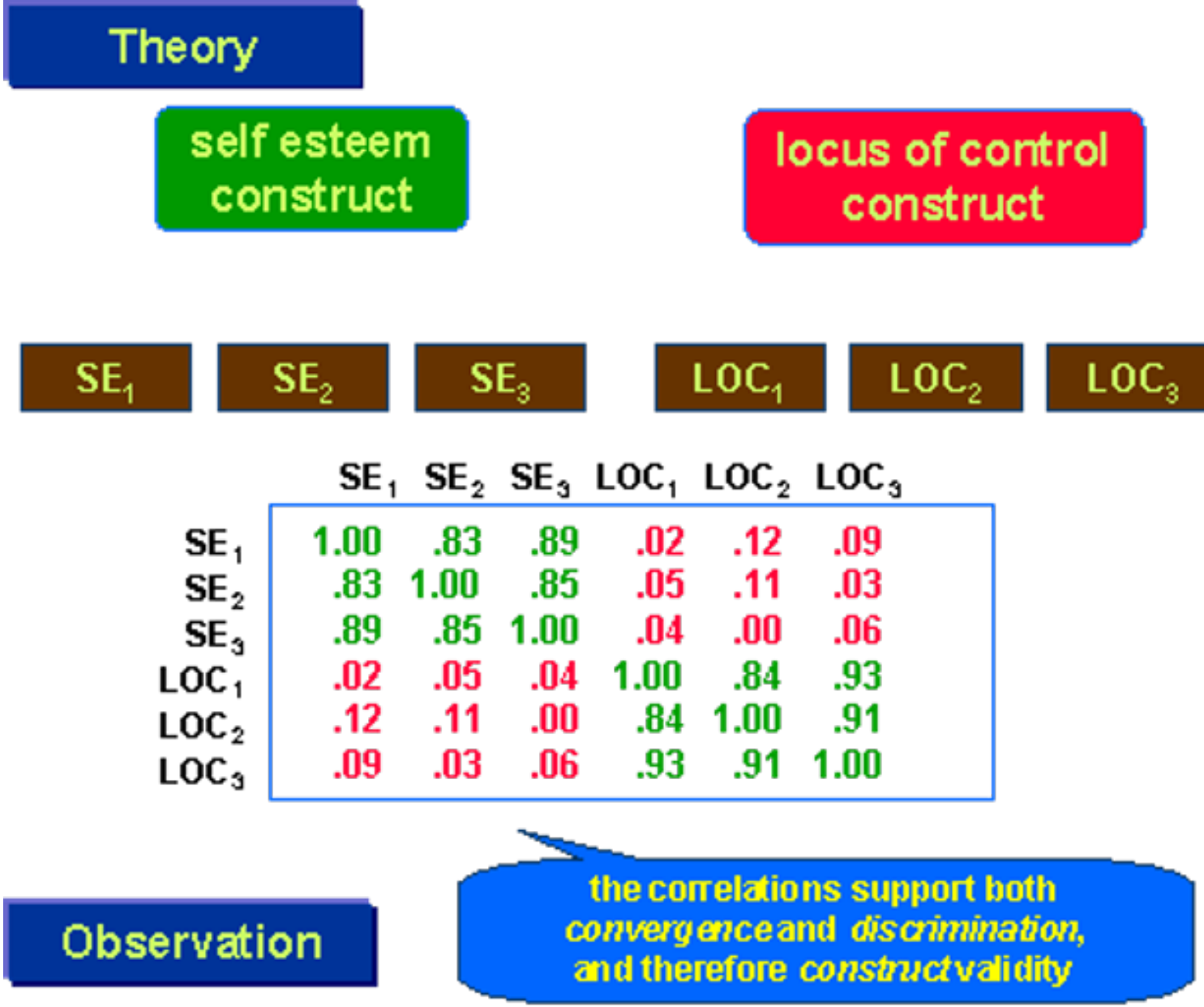

Figure: Construct Validity

Dealing with Errors in Measurement

- In reality, there is always some possibility that the number assigned does not reflect the true value for that case, i.e.:
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- **How to overcome?**
  - Test-Retest Method
  - Cronbach's alpha or Kuder-Richardson Formula

What is Cronbach Alpha: https://statisticsbyjim.com/basics/cronbachs-alpha/

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- **Ratio:** You can construct a meaningful fraction (or ratio) with a ratio variable.